University Concept Team
Draft Report

Dres Zellweger

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The Team

Paul Abramson
Kevin Corker
George Donohue
John Hansman
John Kern
Dennis Koehler
Ed Koenke
Jim Poage
Bill Wood
Dres Zellweger

tap academic creativity, balance
with ATM and flight ops expertise

The Charge

- Develop 2025 Concepts
- Identify Transition Paths
- **Identify Research Agenda**
- Identify University Research Areas

Conduct 5 2-day meetings
Deliver Final Report in July, 2002
Participate in Summer Workshop

Today's Brief – a work in progress

Our Approach

- Identify drivers

- Brainstorm concepts to accommodate drivers

- Identify research questions related to concepts

- Identify cross-cutting research questions

- Develop high level cut at possible transitions

- Update research questions based on transitions

Drivers

- Capacity/Demand/Security
- Cost (sustainability)
- Technology
- Markets/Economics
- Globalization vs “what’s best for U.S.”

Future must be driven by policy for public benefit, not vested interests of special interest groups

Enablers

- Change has traditionally been the result of "enablers"

- Research should be phased to match predicted timing of future "enablers"

-Transition problems have been an inhibitor

  - Our team thinks it's important to learn from the past and understand what is required for successful transition to a new concept

  - Benefits driven transition not likely to work!

Timing

Our team predicts major opportunity in 5-7 years
- workforce (retirement; contract re-negotiation)
- slot controls end
- AIR21 reauthorization
- serious capacity problems
  (major hubs, RJ fleet, air taxis)

Strong political leadership is necessary

Must engage the public

CONCEPTS

- The Bifurcated System
  - High Density Network
  - “Low Density” System
- Autonomous IMC Operations
- Other Concepts
- Airport Capacity

Bifurcated System

High Density Network - Highly Structured - Efficient Flow
Low Density Space - Weakly Structured

- We envision a split of the NAS into 2 separate networks.
- The high density network connects the high demand and congestion nodes and will grow over time as demand rises.
- Hub and spoke may be less dominant, but will stay because of its inherent efficiency
- External and perhaps intertwined with the highly congested hub network will be low density regions. There would be transition points between the 2 networks.
- By splitting the networks it should be possible to better optimize for each operating group.

High Density Network

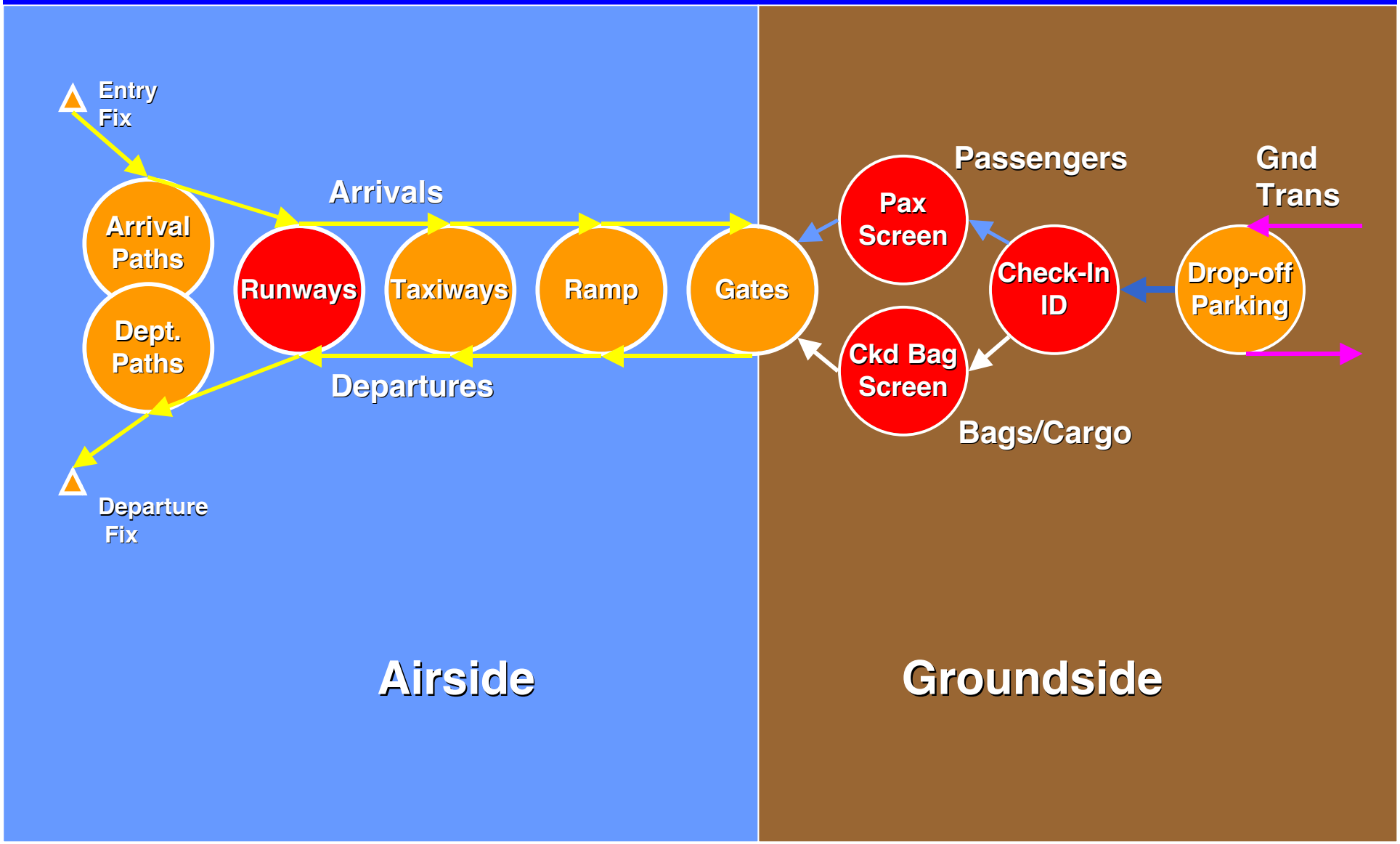
- Different elements of system have to be "impedance matched"

- Has to include airport terminal and landside

- Robustness of total system is important

- Must be based on complete system analysis and design

Key Airport System Flows



The Tube Concept

- Between High Congestion Airports
- Highly Structured Routing for Efficiency, limited flexibility similar to TRACON flows but extend throughout network
- Maximum utilization of key resources
- Inner Loop Control goes to aircraft (RTA, In-Trail Separation, Pair- wise Maneuvering) to increase predictability and capacity
- Ground controls sequence, scheduling and structure

Power of tube is to create an abstraction that allows the controller to deal with many aircraft

The Tube Concept (cont'd)

- Highway metaphor (std routes, on-off ramps, breakdown lane, standard detours around obstructions such as weather)
- Congestion limits and perhaps congestion pricing justifies stringent equipment and operating constraints
- Redesign airspace and procedures around network

- Best chance for early capacity and predictability increase
- But – does not address need for increased throughput at airports

Tube Concept - *Transition*

- Establish Leadership
- Get political and public support
- Get Workforce Buy-in Early
- Identify Issues, Opportunities, Inhibitors/Opposition
- Demonstrate in Experimental Corridors in High Value Target Markets
  - ORD-NYC
  - LA-SFO
  - Washington-New York-Boston
- Limited corridors, simple on/off ramps, break-down lanes
- Pair wise self separation (station keeping) for closer spacing
- Keep technology and procedures simple
- Give preference to demo participants

Tube Concept - *Research*

- Select experimental corridors
- Model and design of tubes and procedures
  - Entry, exit, merge, passing etc
  - Role of controllers
- Develop pair-wise self separation protocols
- Develop non-normal procedures
- Understand interaction with flow management
- Develop interface with rest of system
- Redesign airspace
- Identify equipment requirements
- Prove interoperability with other tools
- Prepare for demo (real time sim, NASA flight demo, industry demo)

Highly Interactive Dynamic Planner

- Long term goal to achieve optimum use of capacity constrained system

- Dynamic air-ground negotiation of trajectories
- Aircraft would fly 4D routes, as a minimum in terminal regions
- Aircraft responsible for separation

- Could evolve from tube concept

Many research issues

-role of people
- dealing with major anomalies
- achieving system stability
- tight 4D planning may over-constrain the problem
- making system safe
- transition
-public acceptance etc etc

Market Based System

-Major Hub Airports will Allocate Slots by Public Auctions:
  -Strategic, near term and spot auctions
  -May price runway occupancy
  -Peak runway loading will be reduced to government established safety and capacity optimized schedules
  -Aircraft size will be driven by a combination of airline profits and maximum enplanement opportunities

-Policy will determine how “national resource” will be used

-System will change behavior and find a new equilibrium

The Regional Airport System

Objective – increase capacity of high demand urban regions, especially where primary airport expansion is limited

- In near term, use of "alternate" airports will grow to accommodate regional airlines, air taxi, fractionals, etc.

- In longer term, these airports could be managed as a single asset
- With appropriate multi-modal connectivity, some percentage of traffic could be dynamically assigned to different airports

- Terminal area ATM will have to be designed for best use

Autonomous IMC Operations
Class Q – below 17,000 ft

By 2025, no longer "low density" – we predict too many planes for ATC as we know it today

- Separation responsibility goes to aircraft
- Traffic management limited to density control
- Sequencing and interaction done by procedure and rules of road
- A ground monitoring function
- Requires an increase in safety over today's VFR system
  (GA VFR safety is an order of magnitude lower than commercial)

- All planes must be equipped
- Restricted zones that a/c can't fly into (avionics protection)
- Segregate from high density airspace (class A)
- Capable of dealing with wx problems – can't fly over weather!

Class Q - *Transition*

- Having a clear Transition Path will be critical
  (Capstone and Safe Flight 21 models not adequate)
- Potential for controller delegation to part of fleet
- Potential for small, but typical "trial" regions
- Mandate equipment to accelerate transition

- Bifurcated System Vision
  - we expect Class Q airspace to grow to higher altitudes
    (i.e. lower density airspace surrounding the high density system)

Class Q - *Research*

- What are airspace density limits?
  - for safety?
  - for communications?
- What else is needed to make system stable?
-What are failure modes and how do you handle them?
- What is ground/satellite infrastructure?
- What kind of ground “ATM” function is needed?
  - for security monitoring
  - infrastructure monitoring
  - for search and rescue
  - what else?
- How do you co-exist with rest of ATC system?
- How do you use ASAS? Wx?
- etc etc

Autonomous “SATS” Airports

“Higher IMC rates at non-towered airports”

Research Issues

- Feasibility?
- Hourly rate (10-15)?
- Avionics requirement?
- Ground based infrastructure?
-How do take advantage of WAAS?
- Need for ground-based system for control?
- Unequipped aircraft?
- Interface to ATC system (does ATC deliver aircraft to a “metering fix”?
- Pilot qualifications and training?

Continue Current ATM Paradigm

"muddling along"

- Can't afford cost of doing same old things
  (will lead to a a system that can't get close to meeting demand.)
  - Economy will adapt!
  - But won't get economic benefits of aviation (steak and lobster will be hard to get in Kansas City)
  - Non-part 121 will slowly be driven out of transportation business.
- More ATM by dispatchers is likely
- Demand management

“muddling along” (cont’d)

-Research Focus:

- WAAS enhancements (new TERPs etc.)
- better information flow
- common situational awareness
- moving CDM to tactical level
- separation stds given knowledge of intent
- best use of ADS-B use in existing environment
- self sep in IMC approaches
- redesign of high volume terminal airspace
  (maybe on big terminal area in east coast)

-mixed equipage constraints

- rethinking first come first serve
- on-going OR to adapt to changes

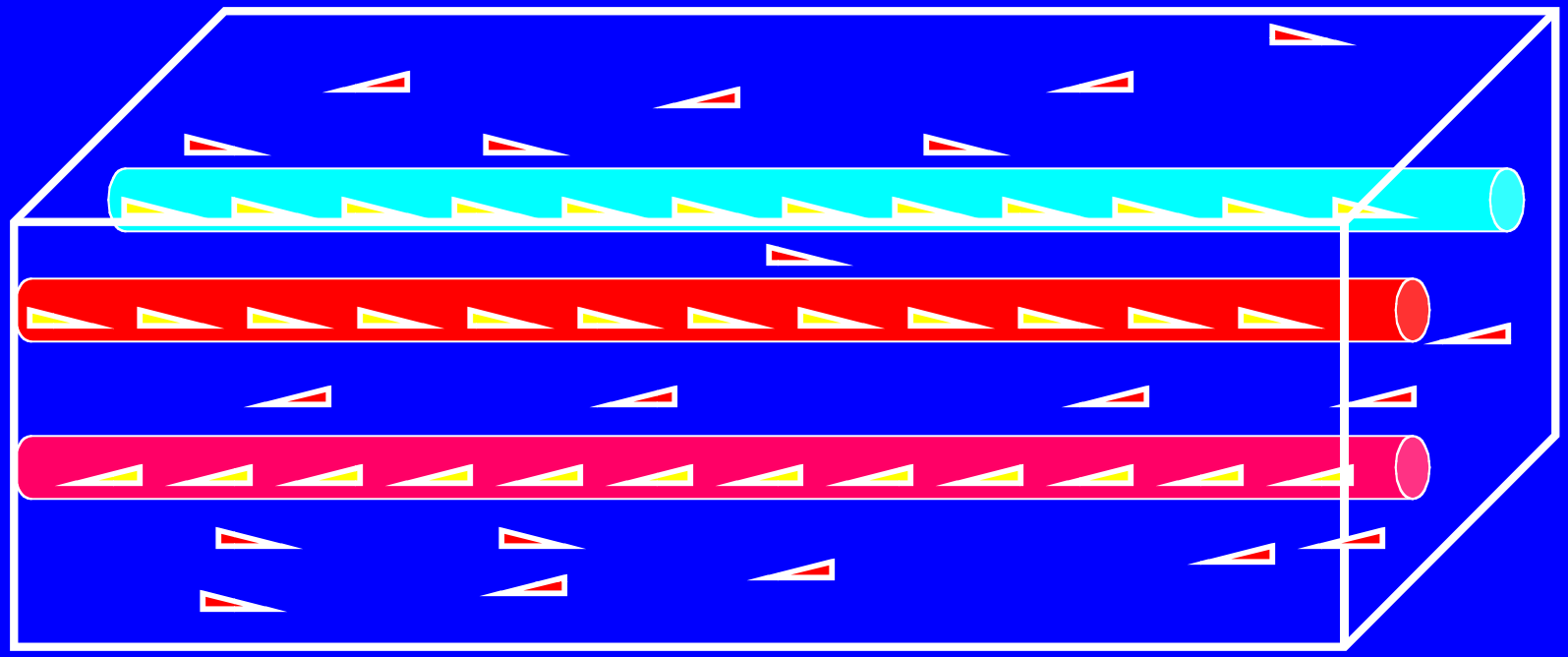
Airports – work still in progress

Crosscutting Research
(very preliminary list)

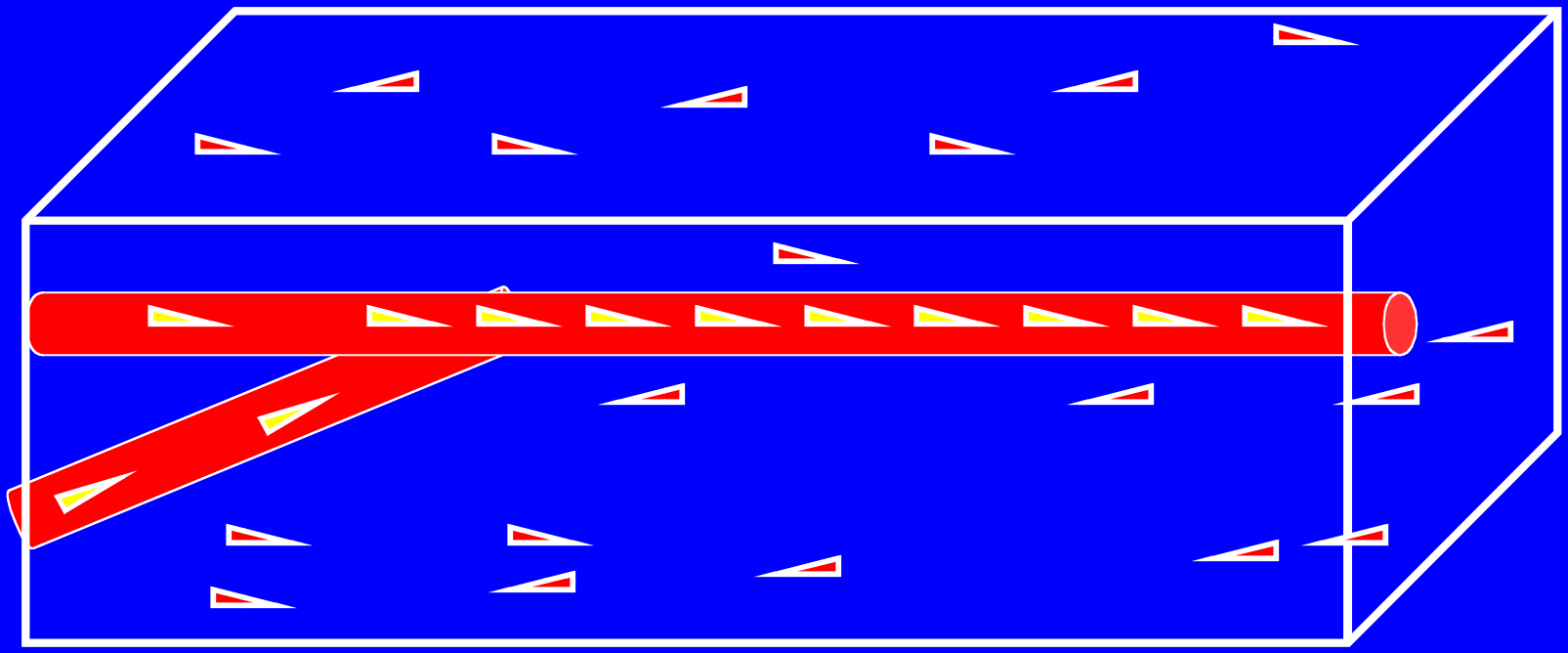
- What are elements of a successful transition?
- Understanding system behavior/dynamics
- Human factors
  (roles/responsibilities; situational awareness, etc.)
- Controller selection and training
- Separation standards
- Ways to reduce capacity variability
  (ex – security, wake vortex, Wx, airport arrival rate)
- How do you deal with major anomalies – when there's a change to a lot of flight paths? What are conditions required to keep system stable?
- CDTI uses – people and equipment

Thank You!

Tube Concept
Interleaved Structured and Unstructured Airspace



Tube Concept
On-Ramp Off-Ramp



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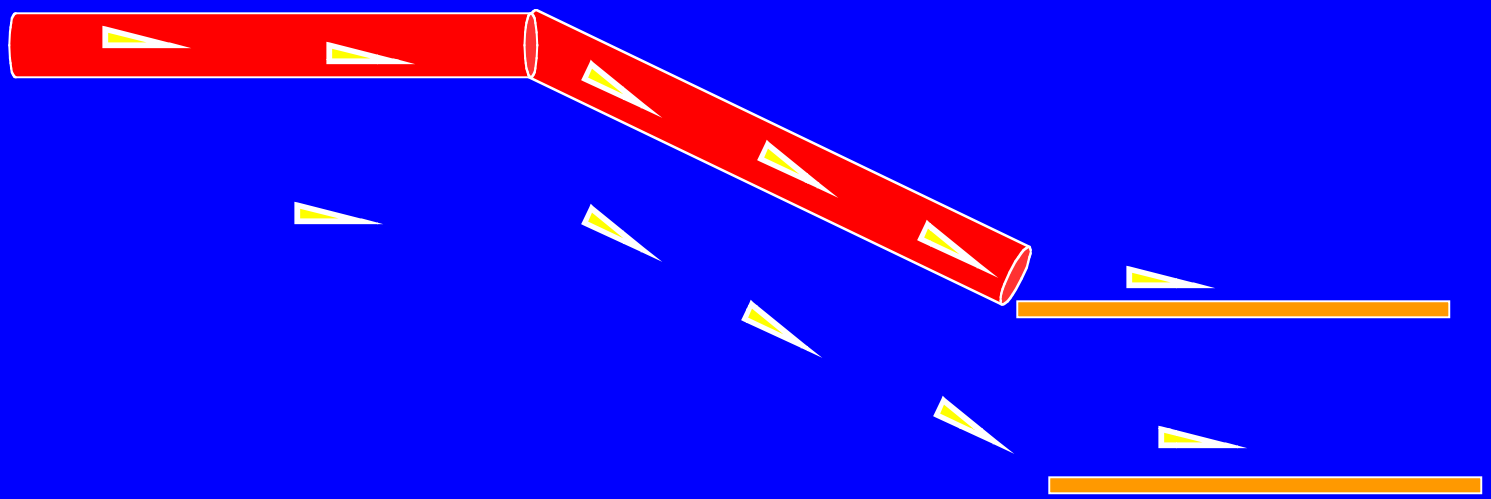

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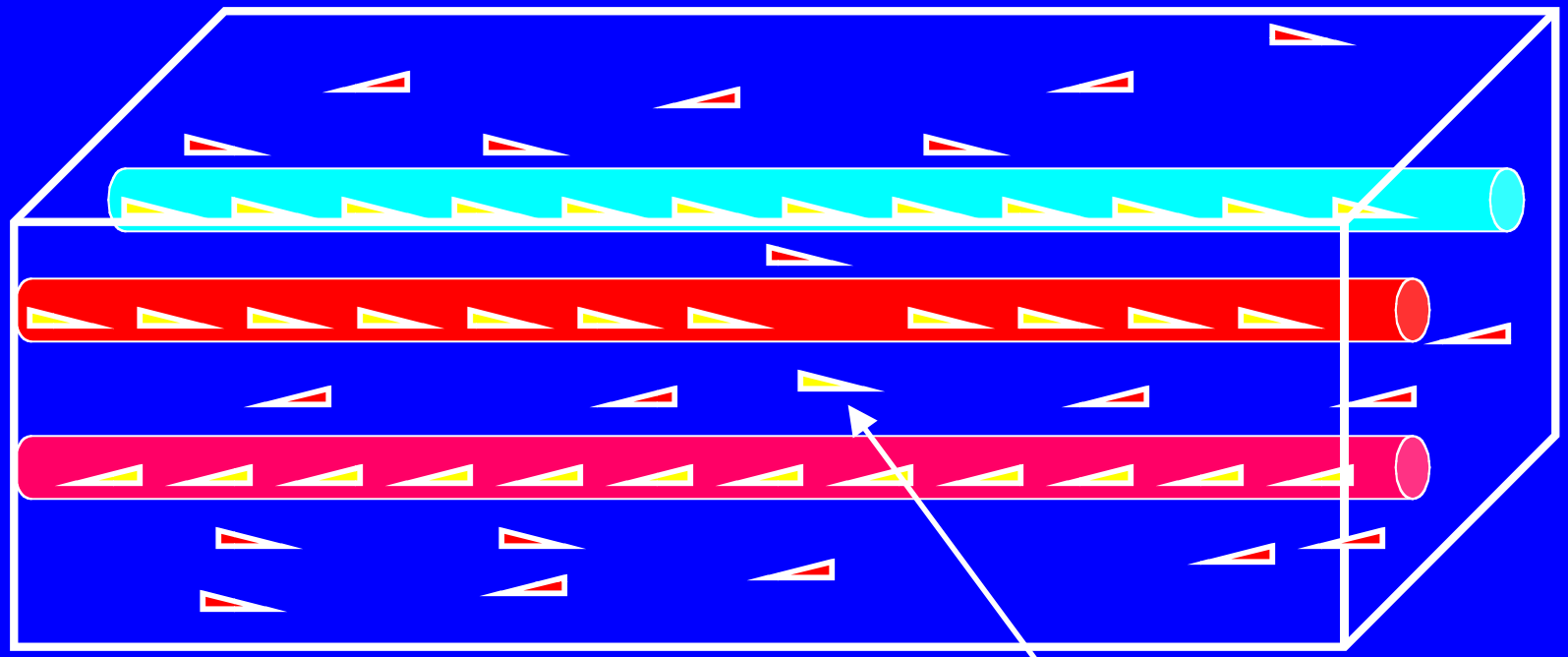

Problem Aircraft Exits Tube into Unstructured Airspace (Breakdown Lane) and Diverts to Backup Airport

Strategy

The problem: How to build an *evolutionary* system that can meet the needs of a *fuzzy future*.

Step 1 - create a VISION

Step 2 - develop a *robust* set of concepts "if you don't know where you're going, any road will get you there"

Step 3 – perform "concept research"

Step 4 - develop high level architecture for the concept(s) - (zoning laws and building codes)

Step 5 - develop a roadmap (transition path) for evolution to this future system

Step 6 - define operational and technology requirements and user consensus for initial waypoints

Step 7 - over time, update vision, concepts, and roadmap and repeat step 6 for next waypoints

In parallel - develop CNS/ATM technologies to fully develop the concepts and details of the "waypoints"

- A ROBUST concept accommodates range of most likely future worlds
- Committing to ROADMAP a step at a time keeps options open
- Implementing steps along a well defined road overcomes "treatment of symptom" syndrome